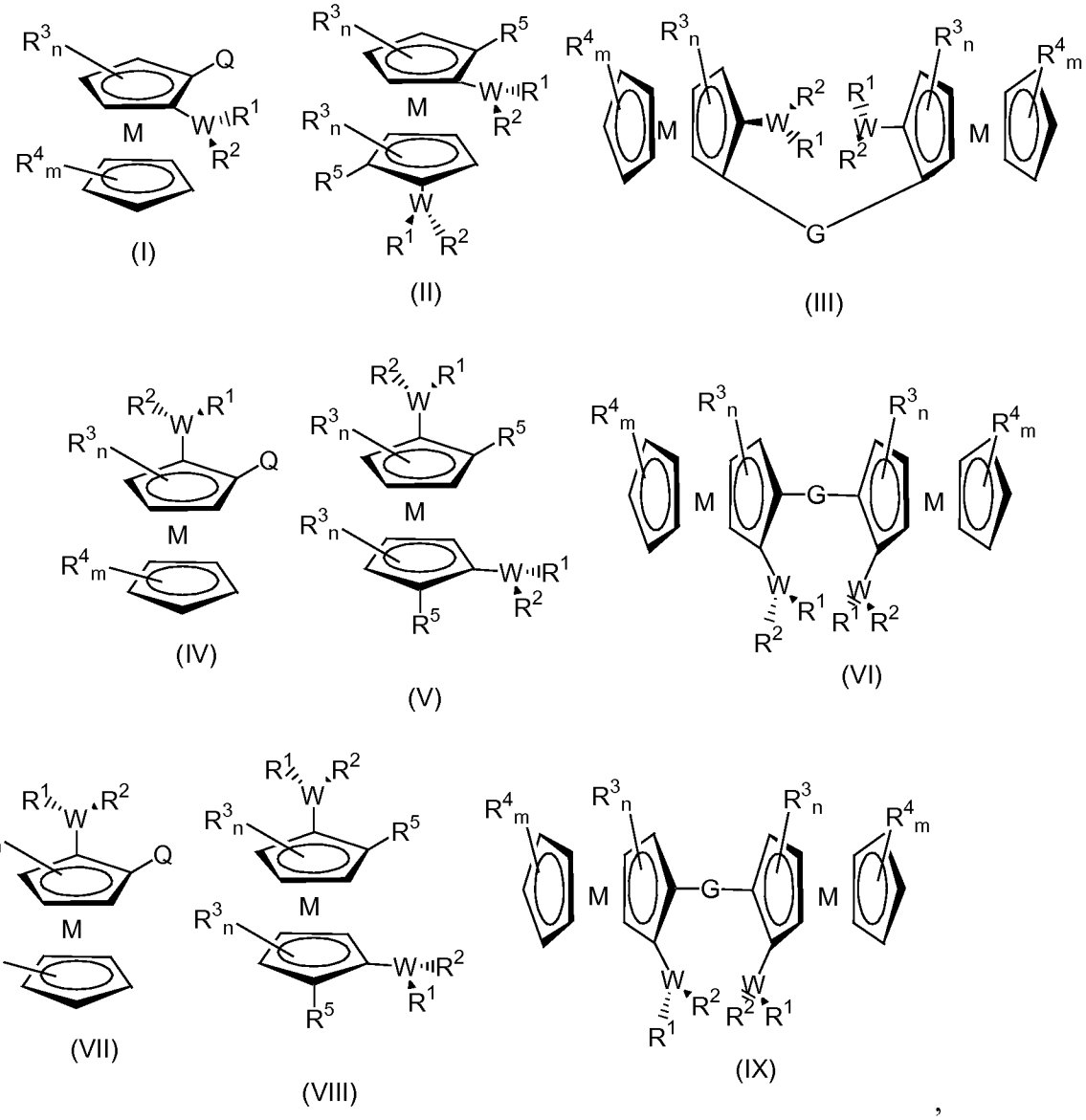
AMENDMENTS TO THE CLAIMS

1-43. (Cancelled)

44. (Currently amended) A metallocene-based ligand having a formula selected from the group consisting of Formula (I), Formula (II), Formula (III), Formula (IV), Formula (V), Formula (VI), Formula (VII), Formula (VIII), and Formula (IX):



,

wherein

W is phosphorus or arsenic;

M is a metal;

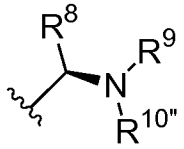
R^1 and R^2 are different from each other and are independently selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroarylamino;

R^3 and R^4 are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl;

n is an integer from 0 to 3;

m is an integer from 0 to 5;

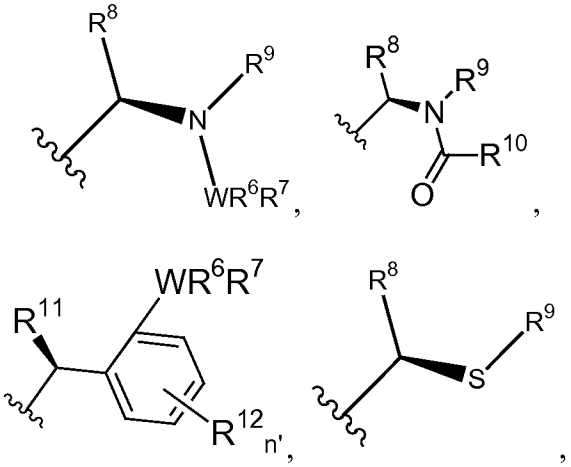
Q is the group



wherein

R^8 is selected from the group consisting of substituted straight-chain ~~alky~~alkyl, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; R^9 and $R^{10"}$ are independently selected from the group consisting of hydrogen, substituted straight-chain alkyl, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; or

Q is selected from the group consisting of



wherein

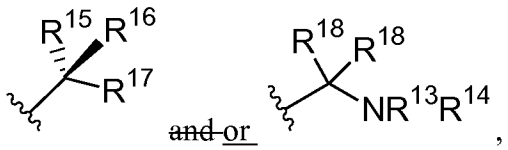
R^6 and R^7 are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, substituted heteroarylamino, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, and unsubstituted heteroarylamino;

R^8, R^9, and R^{10} ~~and $R^{10"}$~~ are independently selected from the group consisting of hydrogen, substituted straight-chain alkyl, unsubstituted straight-chain alkyl, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; R^{11} is selected from the group consisting of OR^{13}, SR^{13}, NHR^{13}, and $NR^{13}R^{14}$, wherein

R^{13} and R^{14} are independently selected from the group consisting of substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and

unsubstituted heteroaryl; R^{12} is selected from the group consisting of hydrogen, halogen, OR^{13}, SR^{13}, $NR^{13}R^{14}$, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl, and n' is 0 to 4;

R^5 is selected from:

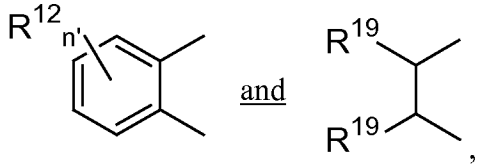


wherein R^{15}, R^{16} and R^{17} are independently selected from the group consisting of hydrogen, halogen, OR^{13}, SR^{13}, $NR^{13}R^{14}$, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; and wherein the two geminal substituents R^{18} together are a doubly bonded oxygen atom, or each substituent R^{18} is individually hydrogen; and G is selected from the group consisting of -C(=O)NH-R*-NHCO-, -C(=O)-OR*O-C(=O)-, -C(=O)-R*C(=O)-, -CH=N-R*-N=CH-, $-CH_2NH$-R*-$NHCH_2$-, $-CH_2NHC(=O)$-R*-$C(=O)NHCH_2$-, $-CH(R^8)NH$-R*-$NH(CH(R^8)$-, $-CH(R^8)NHC(=O)$-R*-$C(=O)NHCH(R^8)$-, -C(=O)NH-R-NHC(=O)-, -C(=O)-ORO-C(=O)-, -C(=O)-RC(=O)-, -CH=N-R-N=CH-, $-CH_2NH$-R-$NHCH_2$-, $-CH_2NHC(=O)$-R-$C(=O)NHCH_2$-, $-CH(R^8)NH$-R-$NH(CH(R^8)$-, $-CH(R^8)NHC(=O)$-R-$C(=O)NHCH(R^8)$-;

wherein R^8 is independently selected from the group consisting of hydrogen, substituted straight-chain alkyl, unsubstituted straight-chain alkyl, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl~~, independently, as previously defined~~;

wherein R^{13} and R^{14} are independently selected from the group consisting of substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl;

-R*- and –R- are selected from the group consisting of:



wherein R^{12} is as previously defined;

wherein the two substituents R^{19} together are $-(CH_2)_{m'}-$ or each substitutent R^{18} is independently selected from the group consisting of hydrogen, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; wherein the or each heteroatom is independently selected from sulphur, nitrogen, n' is an integer of from 0 to 4; and m' is an integer of from 1 to 8.

45. (Previously presented) The metallocene-based ligand of Claim 44, which is a diastereomer having Formula (IV), Formula (V), or Formula (VI).

46. (Previously presented) The metallocene-based ligand of Claim 44, which is an enantiomer having Formula (VII), Formula (VIII), or Formula (IX).

47. (Previously presented) The metallocene-based ligand of Claim 44, wherein the metallocene-based ligand is a phosphine or arsine having chirality at W, and wherein the metallocene-based ligand has at least one additional element of chirality selected from the group consisting of chirality at carbon, and axial chirality.

48. (Previously presented) The metallocene-based ligand of Claim 44, wherein the metallocene-based ligand is a diphosphine or diarsine having chirality at W, and wherein the metallocene-based ligand has two additional elements of chirality comprising chirality at carbon, and axial chirality.

49. (Previously presented) The metallocene-based ligand of Claim 44, wherein the metallocene is ferrocene.

50. (Previously presented) The metallocene-based ligand of Claim 44, wherein W is phosphorus.

51. (Previously presented) A catalyst or catalyst precursor in an asymmetric transformation reaction to generate a high enantiomeric excess of a formed compound, the catalyst or catalyst precursor comprising the metallocene-based ligand of Claim 44.

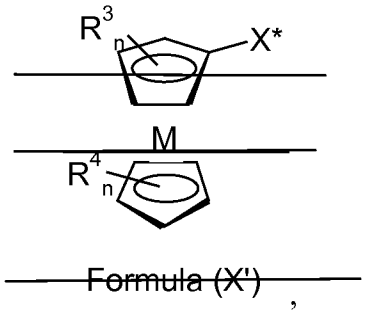
52. (Previously presented) A transition metal complex containing a transition metal coordinated to a ligand according to the metallocene-based ligand of Claim 44.

53. (Previously presented) A transition metal complex according to claim 52, wherein the transition metal is a Group VIb or a Group VIII metal.

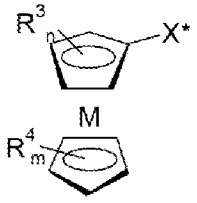
54. (Previously presented) A method for preparing the metallocene-based ligand of Claim 44, comprising:

providing a metallocene-based substrate having a chiral directing substituent on one or both rings;
ortho-lithiating the metallocene-based substrate; and
converting the ortho-lithiated metallocene-based substrate to obtain the metallocene-based ligand.

55. (Currently amended) The method according to Claim 54, wherein the metallocene-based ligand has Formula (I) or Formula (III), wherein the metallocene-based substrate has Formula (X'):



~~Formula (X')~~ ,



Formula (X') ,

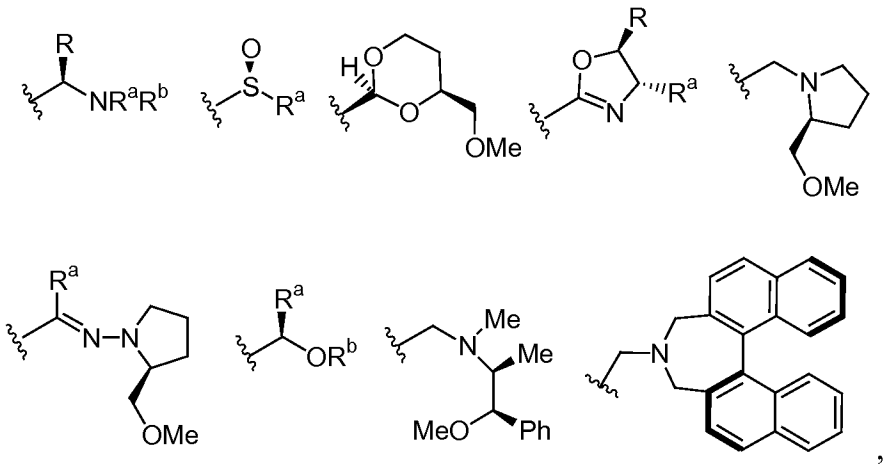
wherein R^3 and R^4 are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl;

n is an integer from 0 to 3;

m is an integer from 0 to 5;

and wherein X* is a chiral directing group, wherein the step of converting the ortho-lithiated metallocene-based substrate comprises reacting the ortho-lithiated substrate with an R^1 substituted phosphine or arsine, and with an R^2-bearing Grignard reagent or an R^2-organolithium compound, then converting X* to Q or G.

56. (Previously presented) A method according to Claim 55, wherein X* is selected from the group consisting of:



wherein

R^a and R^b are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl.

57. (Previously presented) The method according to claim 55, wherein the ortho-lithiation step is conducted using at least one lithiating agent selected from the group consisting of n-butyllithium, sec-butyllithium, and tert-butyllithium.

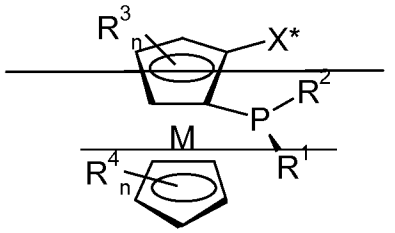
58. (Previously presented) The method according to claim 57, wherein the step of converting the ortho-lithiated metallocene-based substrate comprises reacting the ortho-lithiated metallocene-based substrate *in situ* with a dichlorophosphine of the formula R^1PCl_2 wherein R^1 is selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl,

substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroarylamino;

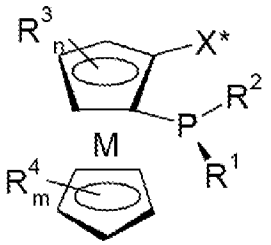
to yield an intermediate product, wherein the intermediate product is converted to obtain the metallocene-based ligand.

59. (Currently amended) The method according to Claim 58, further comprising reacting the intermediate product with an organometallic reagent of formula R^2Z, wherein R^2 is selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroarylamino;

wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having formula (XI'):



~~Formula (XI')~~



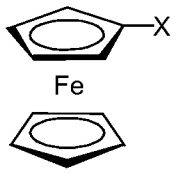
Formula (XI')

wherein the phosphorous chiral compound is converted to obtain the metallocene-based ligand.

60. (Cancelled)

61. (Previously presented) A method for preparing a metallocene-based ligand of Claim 44, comprising:

providing a compound of Formula (XXXVII):



(XXXVII)

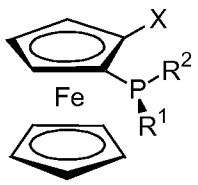
wherein X is an achiral directing group;

subjecting the compound of Formula (XXXVII) to enantioselective mono-ortho-lithiation using at least one lithiating agent selected from the group consisting of n-butyllithium, sec-butyllithium, and tert- butyllithium, wherein the mono-ortho-lithiation is conducted in the presence of a homochiral tertiary amine, whereby a chiral monolithium compound is obtained;

reacting the chiral monolithium compound *in situ* with a dichlorophosphine of the formula R^1PCl_2 followed by reacting with an organometallic reagent of the formula R^2Z, wherein R^1 and R^2 are different from each other and are independently selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy,

unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroarylamino;

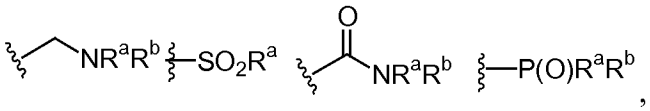
wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having Formula (XXXVIII):



(XXXVIII)

and converting the phosphorus chiral compound having Formula (XXXVIII) to the metallocene-based ligand, wherein the metallocene-based ligand has Formula (I) or Formula (III).

62. (Previously presented) The method according to Claim 61, wherein X is selected from the group consisting of:

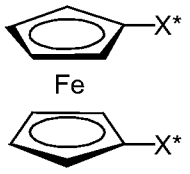


,

wherein R^a and R^b are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl.

63. (Previously presented) A method for preparing a metallocene-based ligand of Claim 44, comprising:

providing a compound of the Formula (XXXIX):

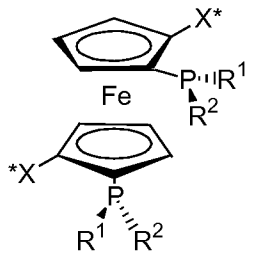


(XXXIX) ,

wherein X* is a chiral directing group;

subjecting the compound of Formula (XXXIX) to bis-ortho-lithiation using at least one lithiating agent selected from the group consisting of n-butyllithium, sec-butyllithium, and tert-butyllithium, whereby a bislithium compound *in situ* with a dichlorophosphine of the formula R^1PCl_2 followed by reacting with an organometallic reagent of the formula R^2Z wherein R^1 and R^2 are different from each other and are independently selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroarylamino;

wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having Formula (XXXX):



(XXXX)

and converting the phosphorous chiral compound having Formula (XXXX) to the metallocene-based ligand, wherein the metallocene-based ligand has Formula (II).